(ii) techniques and procedures used to investigate **PAG8**
PV = constant (Boyle's law) and $\frac{P}{T}$ = constant

(6) M - Define Bolye's law
(7) S - Describe techniques and procedures used to investigate Boyle's law
(8) C - Apply Boyle's law to problems involving pressure and volume

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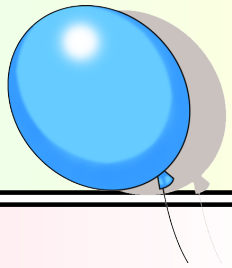
Lesson 3. Boyle's law

STARTER: Take out your gas laws ICT homework



Kilo 10^3
Mega 10^6
Giga 10^9

Variables	Nature of relationship	Constant parameters		Describe why in terms of kinetic theory of matter
V vs P	Boyles $P \alpha \frac{1}{V}$	T, n		Explain why decreasing the volume of a gas at constant temperature increases the pressure.
V vs T	$V \alpha T$	P, n		
T vs P	$T \alpha P$	V, n		
Moles vs V	$V \alpha n$	P, T		

Key point

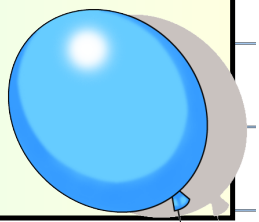
- Boyle's law p α 1 / V pV = constant
- Charles' law V α T V / T = constant
- Pressure law p α T p / T = constant

(6) M - Define Bolye's law
(7) S - Describe techniques and procedures used to investigate Boyle's law
(8) C - Apply Boyle's law to problems involving pressure and volume

ACTIVITY:

Boyle's law $p \propto 1 / V$ pV = constant

How could you define Boyle's law in words (2 statements)?



Kilo 10^3

Mega 10^6 Define Charle's law and the pressure law at the same time.

Giga 10^9

constant quantities

Key point

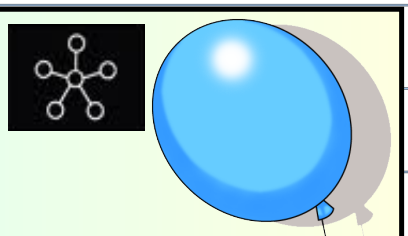
The **volume** of a fixed mass of gas is inversely proportional to its **pressure,** provided the temperature remains constant.

(6) M - Define Bolye's law
(7) S - Describe techniques and procedures used to investigate Boyle's law
(8) C - Apply Boyle's law to problems involving pressure and volume

Boyles law calculations

ACTIVITY:

Complete the calculations below



1. A bubble of diameter 1.5mm escapes from a diver's helmet at a depth of 40m where the pressure is 5.0 atmospheres.

(a) Calculate the minimum diameter at the surface

(b) Why is the diameter likely to be greater than your calculated answer?

2. A cylinder of volume 0.020m^3 contains nitrogen gas at a pressure of 80 atmospheres. The valve is opened and gas is collected at atmospheric pressure until the pressure in the cylinder has fallen to 60 atmospheres. What is the volume of the released nitrogen gas?

Extension:

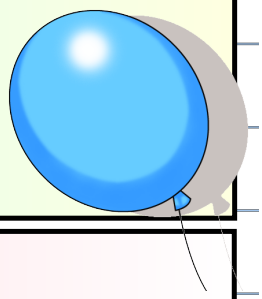
When bubbles rise towards the surface, they expand.
Explain why.

(6) M - Define Bolye's law
(7) S - Describe techniques and procedures used to investigate Boyle's law
(8) C - Apply Boyle's law to problems involving pressure and volume

ACTIVITY 2:

Explain why decreasing the volume of a gas at constant temperature increases the pressure.

Using kinetic theory to help you answer

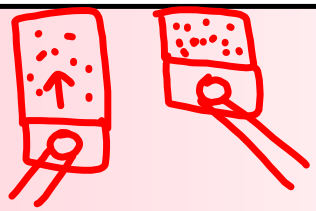


Kilo 10^3

Mega 10^6

Giga 10^9

Use key terms:



Key point

Answers

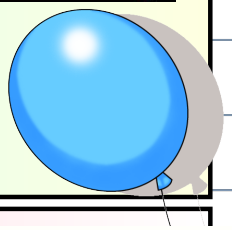
- Same number of particles in smaller volume.
- Greater density of gas
- Each particle same KE (since constant temperature)
- However greater number of collisions per surface area.
- Each collision results in momentum change on surface.
- Therefor same force over smaller surface area means...
- Pressure = force/area therefore greater pressure.

(6) M - Define Bolye's law
(7) S - Describe techniques and procedures used to investigate Boyle's law
(8) C - Apply Boyle's law to problems involving pressure and volume

Investigation Boyle's law

ACTIVITY 2:

Follow the worksheet to investigate Boyle's law.



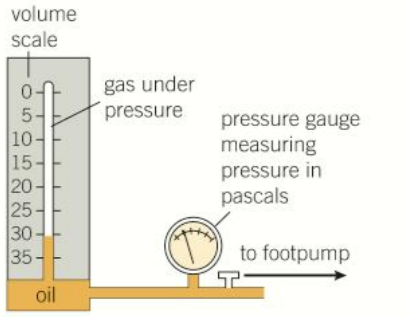
Kilo 10^3

Mega 10^6

Giga 10^9

Complete the follow up sheet as well.

Key point



▲ **Figure 2** *Apparatus for investigating how changing the volume of a gas affects the pressure of the gas (Boyle's law)*

Example data

Pressure p/10^5 Pa	Volume V/cm^3	$\frac{1}{V}$ /cm^{-3}	pV/Nm or J
4.0	7.8	0.13	3.12
3.5	9.1	0.11	3.19
3.0	10.4	0.10	3.12
2.5	12.4	0.08	3.10
2.0	15.6	0.06	3.12
1.5	21.3	0.05	3.20
1.0	31.6	0.03	3.16

Answers for method sheet

1 Boyle's law in words: pressure × volume = constant (*1 mark*) for a fixed mass of an ideal gas at constant temperature. (*1 mark*) (*2 marks*)

2 Changing the temperature of the gas (*1 mark*) or the number of moles (*1 mark*) will affect k. (*2 marks*)

3 pV can have units of J or Nm. (*1 mark*)

4 Systematic errors may come from the zero error of the pressure gauge or the volume gauge. (*1 mark*)

5 Random errors may come from fluctuations of temperature during the investigation. (*1 mark*)

6 Plotting a graph of p against $\frac{1}{V}$ enables the linear relationship to be seen (*1 mark*) and any subsequent analysis of the gradient is easier. (*1 mark*) Plotting p against V shows a curve and it is not possible to determine whether the relationship is inverse or inverse square. (*1 mark*) (*3 marks*)

7 **a** From $pV = k$, we get $pV = 3.14$, so $p = 2.6 \times 10^5$ Pa (*1 mark*)

b From $pV = k$, we get $pV = 3.14$, so $V = 14.3$ cm^3 (*1 mark*) (*2 marks*)